A Systematic Approach To Abnormal Chest Images: Radiographs And Computed Tomograms

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Overview

Presentation Format

CXR interpretive process

Clinical reasoning:
ID CD
Search pattern:
$(ABCD'S)^2$
Systematic process: Volumes
Patterns location: DD

Major CXR Patterns

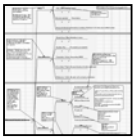
Mass
Consolidative
Interstitial
Vascular
Airway

Summary

Definitions
Patterns
DDG
DDS
Cases, examples

Overview

Presentation Format



- Methodical image interpretation
  - In class, conference, communicaitons and in practice
- Reference to XL algorithm:
  - 60,000-foot aerial view
  - Rather than GPS to specific differential dx
  - Eventually available on Palm and CE as AI
- Map throughout presentation to know topic
  - TX vs. FL, not meant to be read in presentation

Algorithm

Yellow-bordered topic heading

Overview

DEFINITIONS, EXAMPLE REFERENCES

- Pattern - seen on images
  - 5 major categories
- Disease - seen on specimens
- DDG: Differential Diagnosis, General
- DDS: Differential Diagnosis, Specific

References throughout, on MS 2 radiology schedule:
http://rad.usuhs.mil/rad/handouts/ms-2_final.html
Case Studies: http://rad.usuhs.mil/rad/handouts/feigin/abnlcxr/myindex.htm
3 D anatomy:
http://vertex.biostr.washington.edu/cgi-bin/DA/imageform

Overview

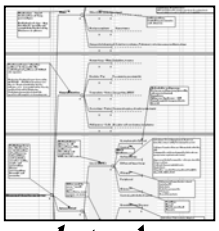
Systematic Process, Methodical

- Lung volumes
  - Big vs. small (think obstructive vs. restrictive)
- Location/ distribution
  - Upper, mid and/ or lower lung fields
  - Focal vs. diffuse. If focal, where,what shape (atelectasis?)
- Patterns (type of opacity)
- DD General, then specific with clinical/ history

Refer to previous studies, when available!

Overview

Map



- Chest algorithm
- Pattern – is seen on images
  - The 5 major patterns **(BOLDFACE)**
  - Disease –seen on path specimens
- DDG: Differential Diagnosis, General
- DDS: Differential Diagnosis, Specific

Overview

Major Patterns of Abnormal Lung Markings

Dx

Mass

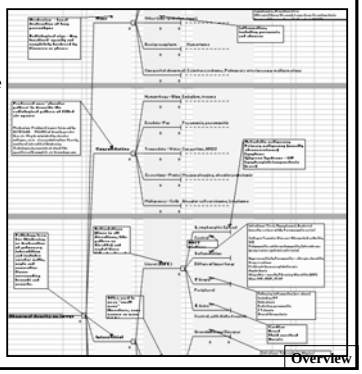
Consolidation

Interstitial

Vascular

Airway

Most Dense

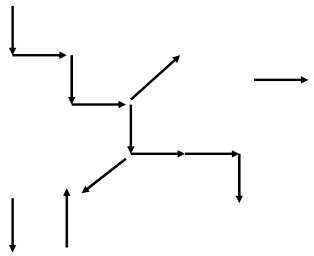


Overview

Image Reasoning

Time of thought

- **Mass**
- **Consolidation**
- **Interstitial**
- **Vascular**
- **Airway**



Pattern Location History SX DX

Overview

Mass

- **Mechanism** - Local destruction of lung parenchyma
- **Radiological sign** - Any localized opacity not completely bordered by fissures or pleura

Mass

Mass Differential Diagnosis

- Malignancy - Primary or secondary
- Granulomatous disease
  - Infectious or noninfectious
  - Active or inactive
- Other inflammation
  - including pneumonia; abscess
- Benign neoplasm
- Congenital abnormality

Mass

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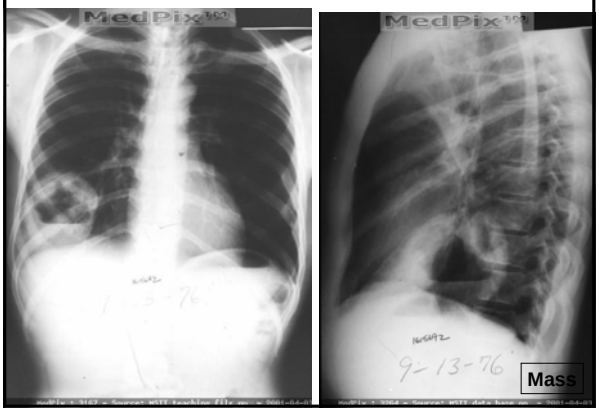


Mass

Bronchgenic carcinoma

3167

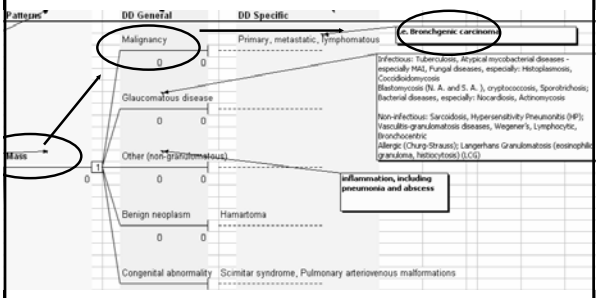
- FINDINGS:
  A cavitated round opacity is present at the right lung base. It overlies the back of the heart shadow on the lateral view.
  There are nodular opacities inside the cavity and an air-fluid level is also visible. The location is thus right lower lobe, with
  possible involvement of the posterior portion of the middle lobe.

  PATTERN:
  The definition of a mass is satisfied.

  DIFFERENTIAL DIAGNOSIS:
  Malignancy is favored over inflammation because of the irregularity of the inner wall of the cavity. The air-fluid level is not useful in differential diagnosis; it indicates only that the bronchus connected to the mass is either partially or intermittently
  obstructed.

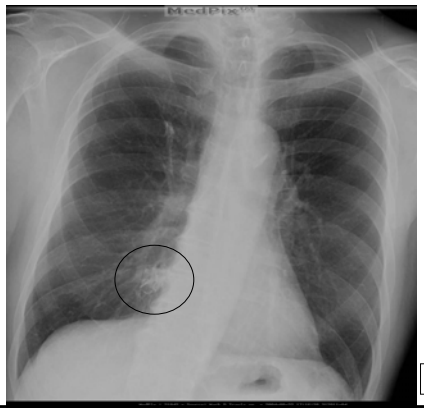
Mass

Mass:
Bronchgenic Carcinoma Pathway



Mass

MedPix 7507



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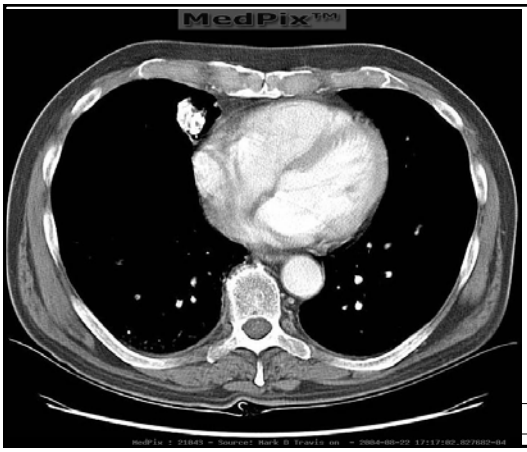


7507

Mass

Pulmonary Hamartoma

- **Hamartomas are benign neoplasms**
  - **90% found in lung**
- **5% of all solitary lung nodules.**
- **CR demonstrate well-circumscribed peripheral rounded or lobulated tumor.**
- **Frequently contain cartilage with fibrous connective tissue and various amounts of fat, smooth muscle, and seromucous glands.**
- **Approximately 30% contain calcium usually of the "popcorn" variety.**
- **Seen most commonly in 4th and 5th decades of life.**
- **They are rare in children.**

Mass

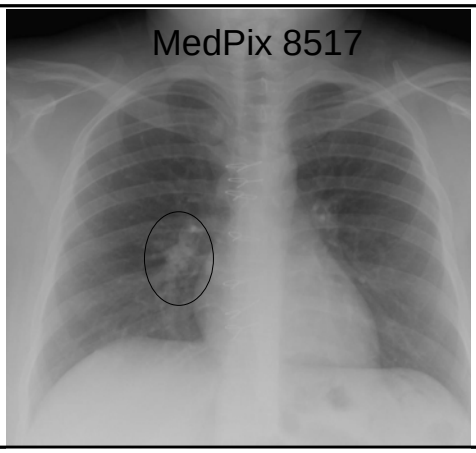
Mass Considerations: Calcifications

- Crucial appearance characteristics for inactivity

  -**Calcification**
  - Central, lamellar
- **Evolution**
  - 2 year stability or regression

Mass

MedPix 8517



Mass

Mass

Pulmonary Arteriovenous Malformation

- **Pulmonary AVM's are abnormal connections between the pulmonary arteries and veins.**
- **They are single in 65%, multiple in 35%. Twice as common in women than men, the majority are congenital and are found in the lower lobes.**
- **Significantly, nearly 70% are associated with Hereditary Hemorrhagic Telangiectasia (Rendu-Osler-Weber disease), an autosomal dominant condition involving multiple AVM's in the brain, lung, skin, and liver.**

Mass

Mass Considerations

Clinical variables
- -Age
- -Symptoms and signs

Risk factors
- -Smoking
- -Occupation, exposure
- -Previous carcinoma
- -Concurrent disease

Note:

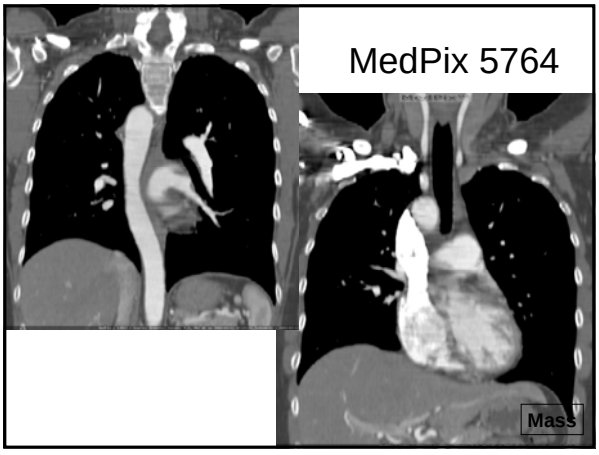
Mass DD included in some vascular and nodular patterns

And the other way around: shades of grey

Mass

- MedPix 5764

Mass



MedPix 5764

Mass

Findings MedPix 5764

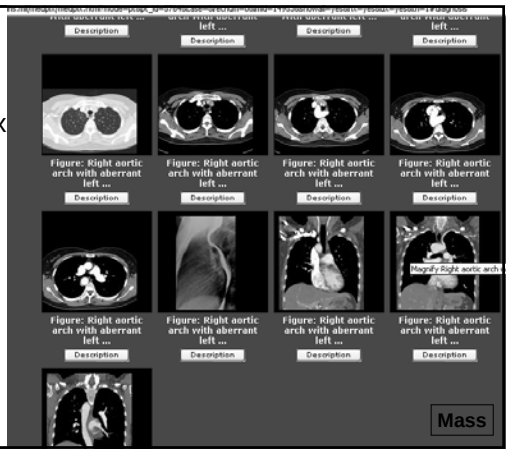
- **Chest plain film: Right sided aortic arch, the lateral view shows an opacity located posterior to the esophagus ans anterior displacement of the trachea.**

  Barium swallow: Extrinsic compression on the posterior wall of the esophagus.

  Chest CT: Right sided arch and an aberrant left subclavian artery arising from a large aortic diverticulum and traveling posterior to the esophagus causing compression on the posterior esophageal wall.

Mass

MedPix 5764



Consolidative (Alveolar) Pattern

Mechanism

-Produced in pure form by **ALVEOLAR FILLING of density greater than air**

-May be mimicked by alveolar collapse, as in airway obstruction

-Rarely, manifests w confluent interstitial thickening

Consolidative

Consolidative (alveolar) **Pattern** *Radiological signs:*

Fluffy, cloud-like, coalescent opacities

Can get sharp edges when limited by fissures or pleura

Complete air bronchograms

Distribution: lobar

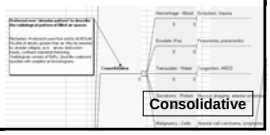
Obliterates pulmonary vasculature

Differentiates from “ground glass”

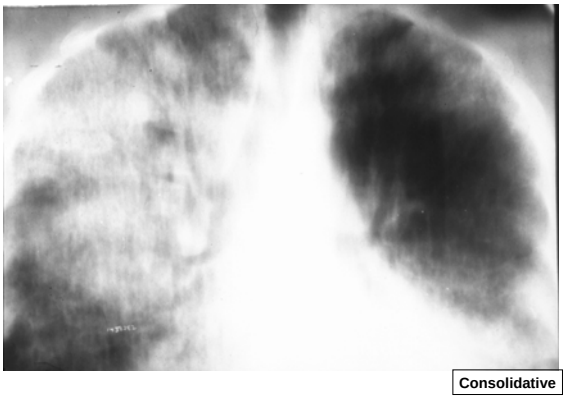
Consolidative

Consolidative (alveolar) **Pattern:** Differential Diagnosis

- Hemorrhage - **BLOOD** - embolism, trauma
- Exudate - **PUS** - pneumonia, pneumonitis
- Transudate - **WATER** - congestion, ARDS
- Secretions - **PROTEIN** - Mucous plugging, Alveolar proteinosis
- Malignancy - **CELLS** - Alveolar cell carcinoma, Lymphoma



Consolidative



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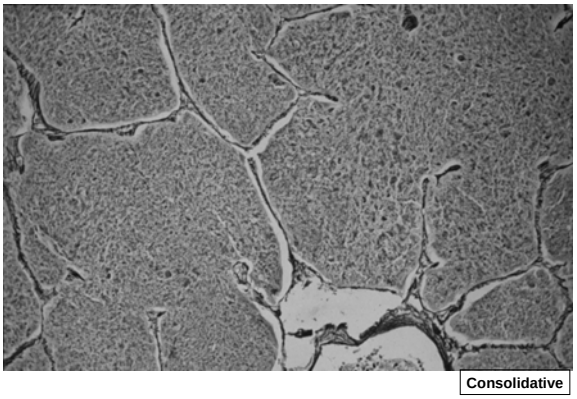

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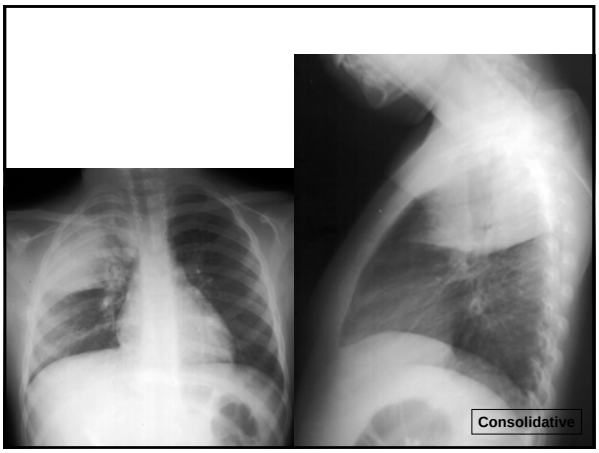


Consolidative

RUL Pneumonia

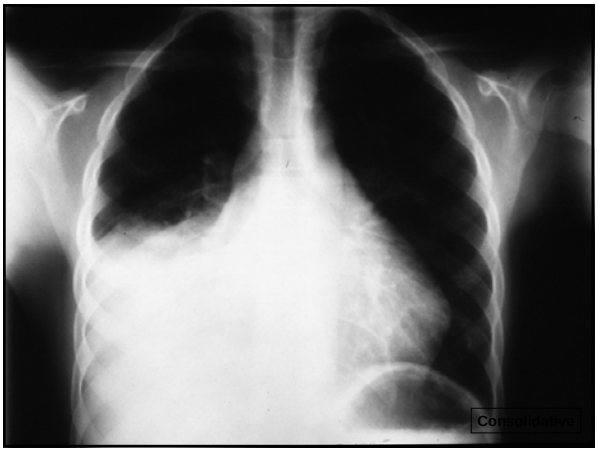
- Large area of opacification on the frontal view has both major and minor fissures as its inferior border.
- The lateral view demonstrates nicely the fissures of the right lung. Both RML and RLL remain well areated.
- MSU Top 10 CXR dx
  - www.rad.msu.edu/.../im_tutor/images/

Consolidative

Bacterial pneumonia

- **Streptococcus pneumoniae is the most common cause of bacterial pneumonia**
- **May present with mild to severe symptoms, including shaking chills, chattering teeth, severe chest pain, and a cough productive of rust-colored or greenish sputum**
- **May be febrile, diaphoretic, tachypneic, dyspneic, and/or cyanotic.**

Consolidative

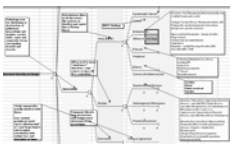


Consolidative

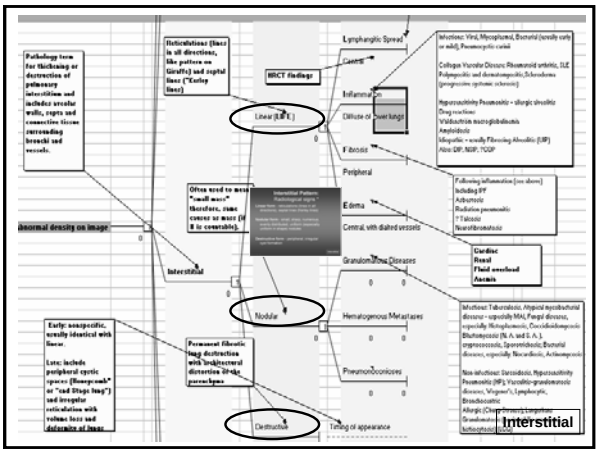
Consolidative

INTERSTITIAL PATTERN

- Mechanism:
  - Thickening of lung interstices
  - Architectural destruction of interstitium
- Appearance: Lines, reticulations
  - That are not vasculature; in addition of



Interstitial



Interstitial Pattern:
Radiological signs *

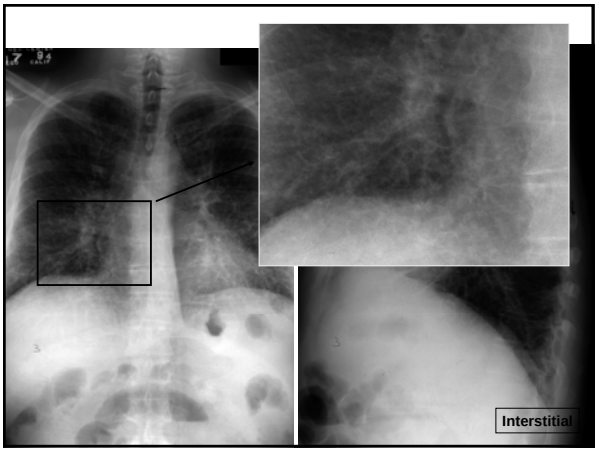
Linear form - reticulations (lines in all directions), septal lines (Kerley lines)

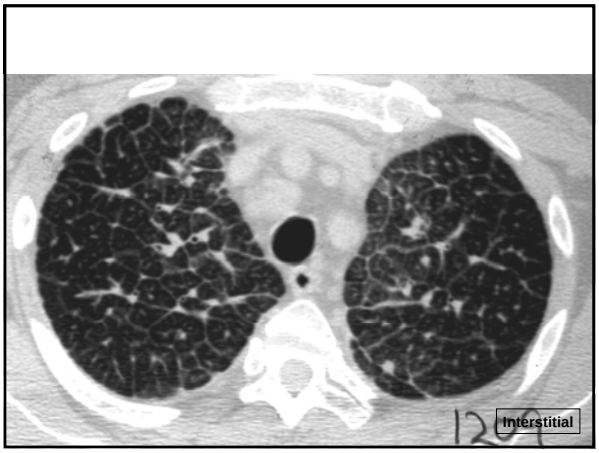
Reticulonodular

Nodular form - small, sharp, numerous, evenly distributed, uniform (especially uniform in shape) nodules

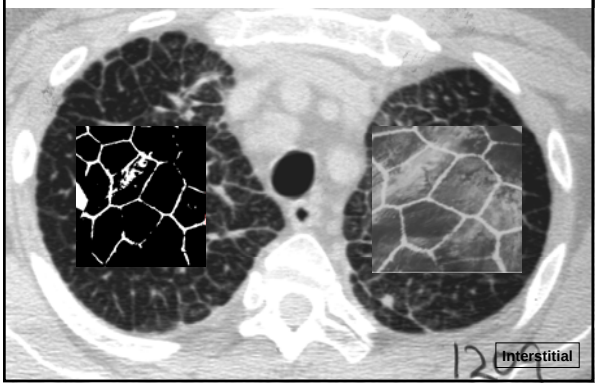
Destructive form - peripheral, irregular cyst formation

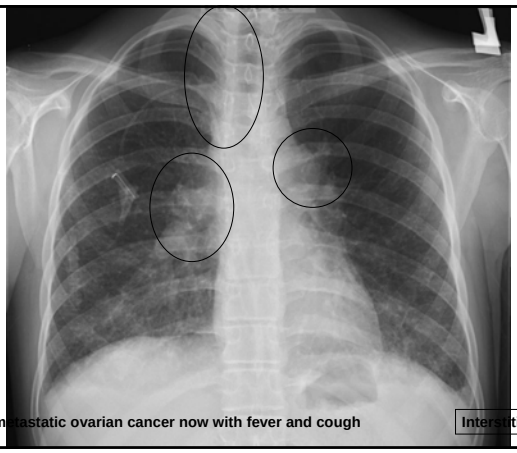
Interstitial





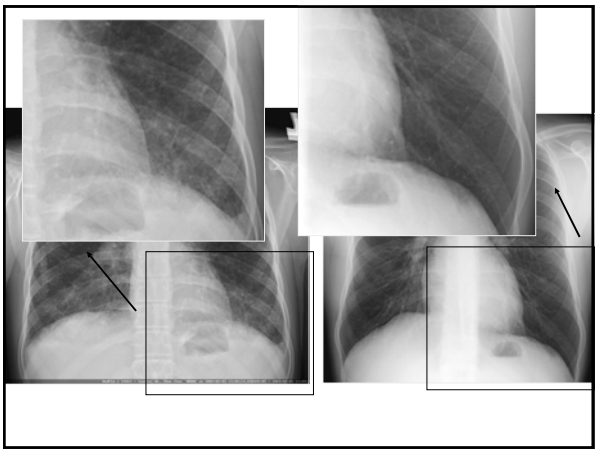
Lymphangitic Spread





HX metastatic ovarian cancer now with fever and cough

Interstitial



Nodular interstitial pattern

Thickened right paratracheal line

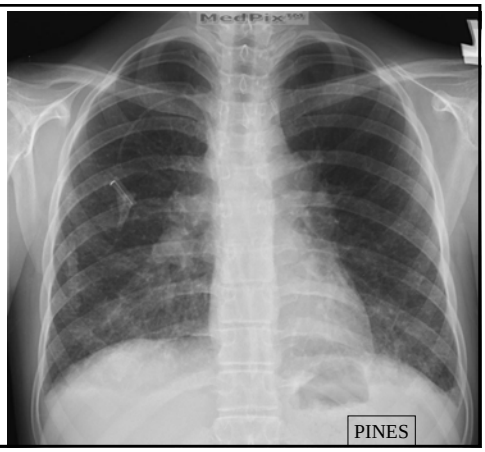
Right mediastinal mass

Bilateral hilar masses

Diff Dx:

Metastatic lung disease consistent with the history of cancer

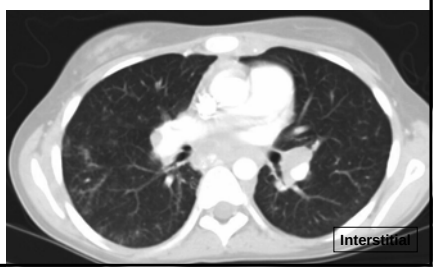
Granulomatous disease



PINES

Small-cell cancer of the ovary with distant metastases

- MedPix 5674, interstial pattern, mass, thick rt paratracheal line on PA

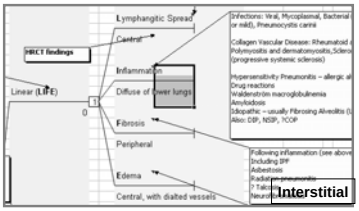


Interstitial

Interstitial Pattern Cont. Differential Diagnosis

- **Linear form - LIFE lines**

-Lymphangitic spread of malignancy
-Inflammation
-Fibrosis
-Edema



Interstitial

LINEAR INTERSTITIAL PATTERN

Specific Differential Diagnosis

- **LYMPHANGITIC SPREAD**

– **Metastatic malignancy**
  - Primary malignancy
    – usually adenocarcinoma
  - Lymphoma (rarely)
  - Sjogrens syndrome – LIP
  - Lymphangioleiomyomatosis (rare)

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

INFLAMMATION
- **Infections**
  - Viral
  - Mycoplasmal
  - Bacterial (usually early or mild)
  - Pneumocystis carinii
- **Collagen Vascular Disease**
  - Rheumatoid arthritis
  - SLE
  - Polymyositis and dermatomyositis
  - Scleroderma (progressive systemic sclerosis)

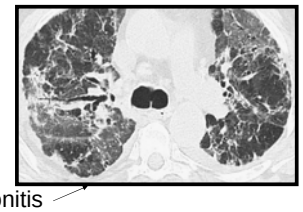
PAP

Hypersensitivity Pneumonitis – allergic alveolitis
Drug reactions
Waldenström macroglobulinemia
Amyloidosis
Idiopathic – usually **Fibrosing Alveolitis (UIP)**
Also: DIP, NSIP, ?COP

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis
- **FIBROSIS**

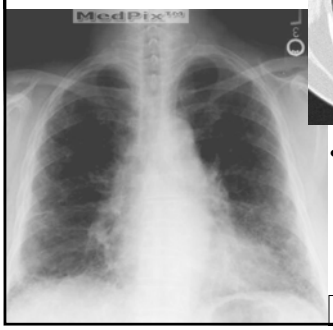
Following inflammation
Including IPF
Asbestosis
Radiation pneumonitis
? Talcosis
Neurofibromatosis

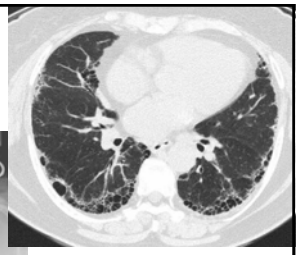


Hypersensitivity Pneumonitis

Patterns → Interstitial → LIFE

Idiopathic Pulmonary Fibrosis





- MedPix

Patterns → Interstitial → LIFE

LINEAR INTERSTITIAL PATTERN
Specific Differential Diagnosis

EDEMA

- Cardiac
- Renal
- Fluid overload
- Anemia

Mnemonic: NOT CARDIAC:

- Near drowning
- Oxygen therapy
- Transfusion or Trauma (fat embolism)

- Central nervous system disorder
- Allergic alveolitis
- Renal failure
- Drugs
- Inhaled toxins
- Aspiration or ARDS or Altitude sickness
- Contusion

Patterns → Interstitial → LIFE

MedPix 9067 (COW);
HX: 17 y/o M in ED w Heroin overdose

Interstitial

Findings, DX

- Bilateral patchy diffuse opacities predominantly in mid to upper lung fields
- DDG:
- • Noncardiogenic pulmonary edema
  • Cardiogenic pulmonary edema
  • Allergic reaction
  • Lymphangitic spread
- DDS:
- **Noncardiogenic Pulmonary Edema**

http://rad.usuhs.mil/medpix/parent.php3?mode=cowpt&pt_id=9067&case=&recnum=0&imid=27311&showall=yes&hx=yes&dx=yes&th=1#diagnosis

http://radiographics.rsnajnls.org/cgi/content/full/19/6/1507

Interstitial

Interstitial Pattern Cont. Differential Diagnosis

- **Nodular form**

  Granulomas
  Hematogenous spread of malignancy
  Pneumonoconiosis

Since nodules are essentially small masses, include mass differential

Patterns → Interstitial → Nodular

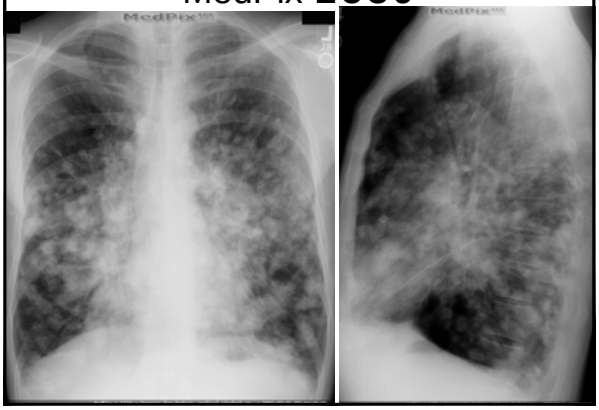
Squamous cell carcinoma identified by open lung biopsy after failed transbronchial biopsy.

Differential:
Miliary TB
Viral pneumonia
Metastatic carcinoma
Sarcoidosis

MedPix 2589

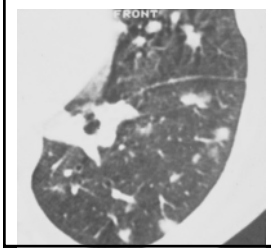
http://rad.usuhs.mil/medpix/medpix.html?mode=pt&pt_id=2589&case=&recnum=1222&imid=1125&find=-1&ddx=-1&showall=yes&hx=&th=1&dx=-1#diagnosis

MedPix **2589**



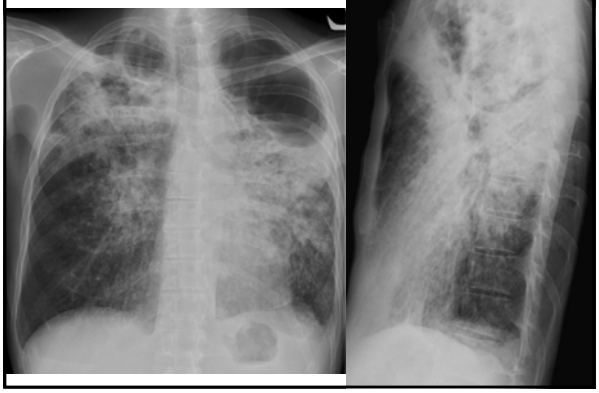
INTERSTITIAL PATTERN: Nodular
Specific Differential Diagnosis

Granulomatous Diseases: Infectious:
Tuberculosis (miliary example below)
Atypical mycobacterial diseases - especially MAI



Patterns → Interstitial → Nodular

Active Pulmonary TB: MedPix



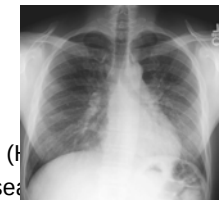
INTERSTITIAL PATTERN: Nodular
Specific Differential Diagnosis

Granulomatous Diseases
Fungal diseases, especially:
Histoplasmosis
Coccidioidomycosis
Blastomycosis (N. A. and S. A.)
Cryptococcosis
Sporotrichosis
Bacterial diseases, especially:
Nocardiosis
Actinomycosis

Patterns → Interstitial → Nodular

INTERSTITIAL PATTERN: Nodular

Specific Differential Diagnosis

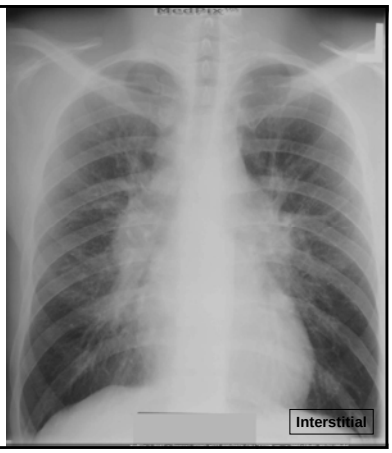


Granulomatous Diseases

Non-infectious
- Sarcoidosis
- Hypersensitivity Pneumonitis (H
- Vasculitis-granulomatosis disea
  - Wegener's
  - Lymphocytic
  - Bronchocentric
  - Allergic (Churg-Strauss)
- Langerhans Granulomatosis (Hist

Patterns → Interstitial → Nodular

MedPix 4017



Sarcoid
MedPix 4017

- **A** granulomatous disease of unclear etiology, most commonly recognized by its thoracic manifestations of interstitial lung disease and hilar and mediastinal adenopathy.
- A multisystem disease, with histologic evidence of **sarcoid** involvement of the liver and spleen seen in 50-80% of all surgical specimens, although most cases do not result in organ dysfunction.

Interstitial

Pneumoconioses

- B CHAOS:
  - Berylliosis
  - Coal worker's Pneumoconioses
  - Hard metal disease
  - Asbestosis
  - Others
  - Silicosis

Patterns → Interstitial → Nodular

Interstitial Pattern

Destructive form

- Early appearance is nonspecific
- Late findings include peripheral cystic spaces
  - Honeycomb or "End Stage Lung" with volume loss and deformity of lungs

Patterns → Interstitial → Destructive

Miliary Nodular

INTERSTITIAL PATTERN MedPix

- TEMPEST

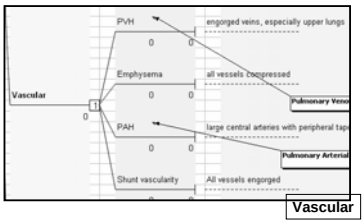
T TB, FUNGAL, VIRAL PNEUMONIAS
E EG
M METS (THYROID, RENAL)
P PNEUMOCONIOSES, PARASITES
E EMBOLISM OF OILY CONTRAST (LIPOID PNEUMONIA)
S SARCOIDOSIS, SILICOSIS
T TUBEROUS SCLEROSIS

Interstitial

VASCULAR PATTERN

- **Mechanism** - increased or decreased perfusion altering diameter of pulmonary vessels

Radiological signs - changes in diameter of specific vessels



Vascular

Vascular Pattern DDG: Examples

- Common examples
  - **Congestion** - engorged veins, especially upper lungs
  - **Emphysema** - diminished vessels
  - **Shunt vascularity** - all vessels enlarged
  - **Lymphangitic carcinoma** - irregular infiltration around vessels may resemble vessel enlargement

Vascular

Vascular Pattern DDG: Examples, cont.

- -**Arterial hypertension** - large central arteries with peripheral tapering
  - **Thromboembolism** - locally diminished vessels with possible vessel mass centrally located
  - **Bronchial circulation** - irregular vessels in unusual directions

Vascular

PAH vs. PVH

Pulmonary Arterial Hypertension

enlarged central and hilar vessels
pruned peripheral vessels
mosaic perfusion
cor pulmonale
PA atherosclerosis

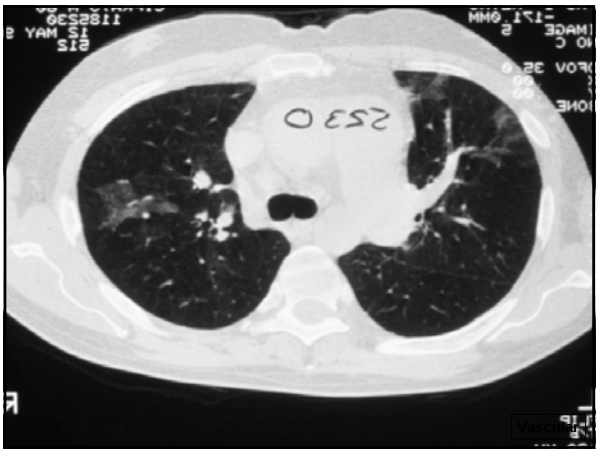
Pulmonary Venous Hypertension

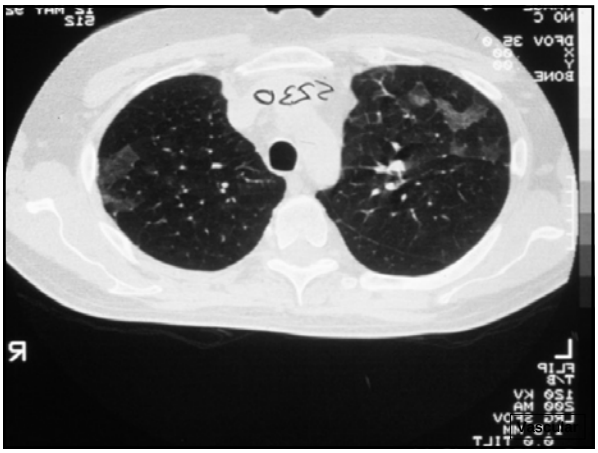
septal lines
smooth pleural thickening
pleural effusion
ground glass opacity

Vascular

Vascular

Vascular





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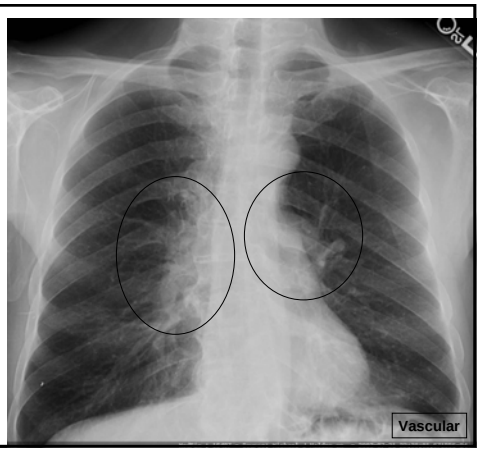
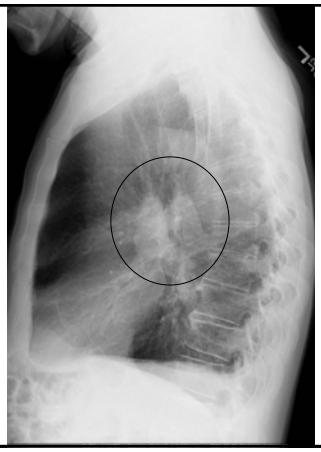


Pulmonary arterial hypertension



AIRWAY (BRONCHIAL) PATTERNS

- Mechanism:
- Complete or partial obstruction of airways
- Thickening of airway walls
  - or displacement of vessels due to overaeration, COPD, etc.

Airway

Airway (bronchial) Pattern; Forms

Complete airway obstruction
- opacity and decreased volume

Partial obstruction
- lucency and increased volume

Wall thickening
- tram tracks, central cystic spaces or circles

Airway

Airway (bronchial) Pattern DDG

-**Opacities** - endobronchial malignancies, granulomas, inflammatory, benign or congenital masses, mucous plugs, foreign bodies

-**Lucencies** - COPD, cysts, blebs, pneumatoceles

-**Thickening** - bronchiectasis, chronic bronchitis

Airway

Airway Patterns cont. Additional signs with CT

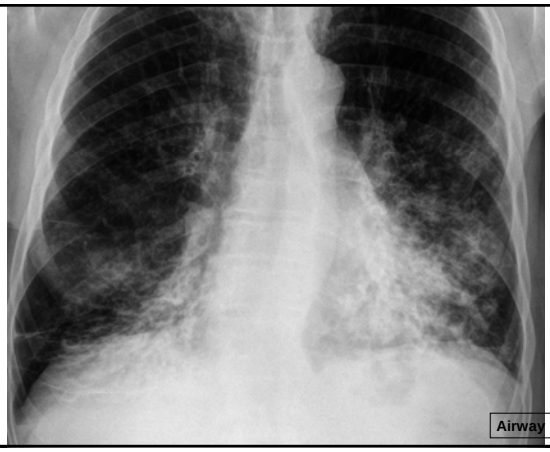
-Thick-walled airways, circular on end, often "signet rings"

-Cystic spaces centrally located

-Cystic spaces with very thin walls or no apparent walls

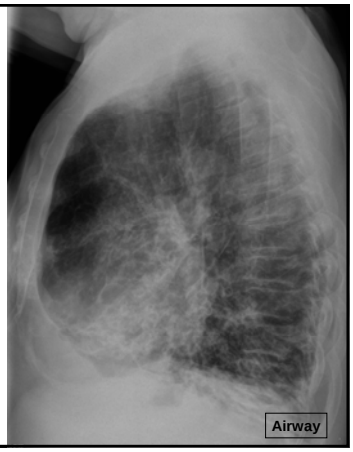
-Thin, stretched vessels
-Bronchiectasis

Airway

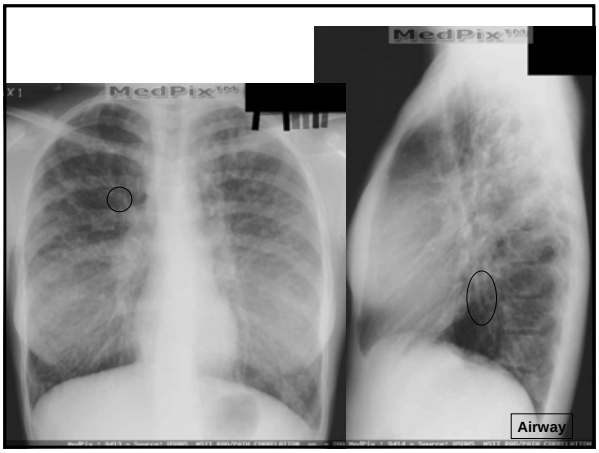


Airway

- **Bronchiectasis**



Airway

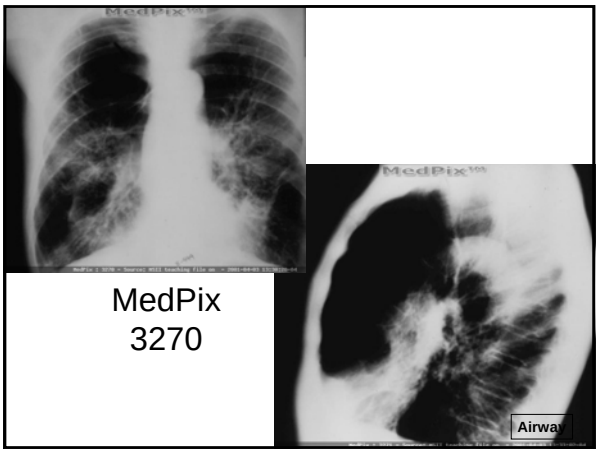


Airway

MedPix 9413 Cystic Fibrosis

- **The radiographic findings are largely secondary to the bronchial obstructions by the thick adherent secretions. Pulmonary hyperinflation is evidenced in this case by the narrow heart and mediastinum and the slightly depressed diaphragm.**
- **The hila are prominent and there, is lobulated contour of the right hilum consistent with the presence of adenopathy which is common in these patients. The most prominent findings in this patient are the changes related to bronchiectasis.**
- There is bronchial wall thickening seen as bronchial cuffing or "tram lines". Dilated bronchi are particularly well seen in the upper lungs where widened tubular and branching lucencies can be seen peripherally some of which containing tubular opacities representing impacted mucus.

Airway



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Airway

COPD with bullous emphysema

- FINDINGS:

  The lungs are hyperinflated and the diaphragms are markedly flattened, especially on the lateral view. There are numerous lucent "holes" in the lungs and the vessels are displaced and asymmetrical.

  PATTERN:

  Air trapping is present, especially in multiple bullae with thin walls. These are the findings of bullous emphysema. Most such patients have COPD, the most common of all airway diseases.

  DIFFERENTIAL DIAGNOSIS:

  A few emphysematous patients have normal airways, with abnormal elasticity of alveolar walls, such as in alpha one antitrypsin deficiency.

  DIAGNOSIS: COPD with bullous emphysema

- http://rad.usuhs.mil/medpix/medpix.html?mode=single&recnum=1696&th=1&im

Airway

Small Airway Disease cont.

- Examples of bronchiolitis

-Infectious - e.g., Viral, mycoplasmal

-Allergic
  -Toxic - e.g., chlorine, phosgene
  -Idiopathic

Airway

Summary

Overview
- Definitions
- Patterns
- DDG
- DDS
- Cases, examples

CXR interpretive process

Clinical reasoning:
- ID CD

Search pattern:
- $(ABCD'S)^2$

Systematic process: Volumes
- Patterns location: DD

Major CXR Patterns

Mass
Consolidative
Interstitial
Vascular
Airway

Quiz: available on-line

Questions:
Today, Friday and Monday

Overview